PUBLISHED DOCUMENT

PD CEN/TR 14920:2005

Jetting resistance of drain and sewer pipes — Moving jet test method

ICS 93.030

British Standards

National foreword

This Published Document is the official English language version of CEN/TR 14920:2005.

The jetting resistance test method was developed in response to a request from CEN/TC 165. The proposed standard was to incorporate both stationary and moving jet tests as material and system tests, based on those developed by WRc in the preparation of its sewer jetting code of practice. In order to obtain European approval for publication as a Technical Report the stationary jet test was removed.

The UK participation in its preparation was entrusted to Technical Committee B/505, Waste water engineering, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

Summary of pages

This document comprises a front cover, an inside front cover, the CEN/TR title page, pages 2 to 14, an inside back cover and a back cover.

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ICS 93.030

English version

Jetting resistance of drain and sewer pipes - Moving jet test method

Résistance des tubes pour les branchements et les collecteurs d'assainissement durant le procédé de débourbage sous haute pression - Méthode d'essai

Widerstandsfähigkeit von Rohrleitungsteilen für Abwasserkanäle und -leitungen beim Hochdruckspülen - Prüfung mit beweglicher Düse

This Technical Report was approved by CEN on 23 August 2004. It has been drawn up by the Technical Committee CEN/TC 165.

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Foreword

This document (CEN/TR 14920:2005) has been prepared by Technical Committee CEN/TC 165 “Waste water engineering”, the secretariat of which is held by DIN.

High pressure water jetting has become more used in cleaning practice of drains and sewers. Considering that, CEN/TC 165 decided to develop a test method for the resistance of pipe materials against high pressure water jetting.

Due to a low level of experience with the newly developed test method applied to different materials and considering some aspects of reproducibility have not been proved, a European Standard is not feasible for the time being. Therefore CEN/TC 165 decided to give initial guidance to the market by publishing a test method as a Technical Report (CEN/TR).

The test method specified in this document is intended to simulate the effect of high pressure cleaning on drains and sewers.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this CEN Technical Report: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This document specifies a test method for the resistance to high pressure clean water jetting of pipes, fittings and joints used for drains and sewers.

This test method is also applicable to components for renovation and replacement of drains and sewers.

2 Definitions and Symbols

For the purposes of this Technical Report, the following definitions and symbols apply.

2.1 Definitions

2.1.1
jet power
P_j
energy per time unit of the jet leaving a nozzle

NOTE Jet Power is expressed in Watts.

2.1.2
jet power density
D_j
jet power per unit of the impinged area

NOTE Jet power density is expressed in Watts per square millimetres.

2.1.3
jet spread angle
ω
spread of the jet related to its axis

NOTE Jet spread angle is expressed in degrees.

2.1.4
Nozzle
assembly of components which convert high pressure water flow into a jet (see Figure 1a)

2.1.5
Nozzle insert
special ceramic component to form a specified jet (see Figure 1c)

2.2 Further symbols

Table 1 — Symbol

Symbol	Term	Unit
α	angle of the jet axis to the test surface (see Figure B.1)	°
C_d	coefficient of discharge of a nozzle	—
d	orifice diameter of the nozzle insert	mm
h	vertical distance between the test surface and the centre of the nozzle orifice	mm
p	pressure measured not more than one metre upstream of the nozzle	MPa
Q	flow rate	l/min

3 Test method

3.1 Principle

A high pressure water jet is directed at a specified angle to and distance from the test surface. It is moved relative and parallel to the test surface. The resulting mechanical load (expressed as jet power density) is kept within specified limits for the duration of the test by controlling the parameters of water pressure, flow rate, distance and jet spread angle. The nozzle and the insert to be used are specified in this document.

After the test the surface of the test piece is inspected.

3.2 General Requirements

3.2.1 Water source

The water is in accordance with drinking water quality standards in respect of chemicals and particulates.

3.2.2 Pressure measurement

A pressure measurement device with an accuracy of ± 0,1 % is connected to the water supply no more than 1 m from the nozzle. The pipe between the position where the pressure is measured and the nozzle shall have an unrestricted bore not less than 15 mm.

3.2.3 Test temperature

The test is carried out at an ambient air temperature of (15 ± 10) °C with water at a temperature of (15 ± 10) °C near the pump inlet.

3.3 Apparatus

3.3.1 Pump unit

The pump unit is capable of delivering water at a pressure of at least 15 MPa and a flow rate of at least 60 l/min. A pressure equaliser is incorporated, if necessary, to limit the pressure variations due to pump action to ± 1 % of the mean value.

3.3.2 Flow rate and pressure accuracy

A means of measuring flow rate to an accuracy of ± 0,1 l/min at a flow rate of (46 ± 0,5) l/min and a means of measuring the pressure no more than 1 m from the nozzle to an accuracy of ± 0,1 % at a pressure of (12 ± 0,2) MPa is used

3.3.3 Nozzle

All dimensions of the nozzle shall conform to Figure 1. The nozzle shall have a ceramic insert with an orifice diameter of (2,80 ± 0,02) mm. The diameter is measured to an accuracy of ± 0,002 mm. The ceramic insert shall produce a jet spread angle of $\omega \leq 3{,}3°$ and is checked according to Annex B.

When using this nozzle together with the specified nominal test parameters, the jet power density D_j is 480 W/mm^2 when calculated according to Annex C. Nominal test parameters are in accordance with Table 2:

Table 2 — Nominal test parameters

Test parameter	Value	Note
Q	46 l/min	(see 3.6.1)
p	12 MPa	(see 3.6.1)
h	10 mm	(see 3.4)
α	30°	(see 3.4)
d	2,8 mm	(see 3.3.3)

Measurements in mm

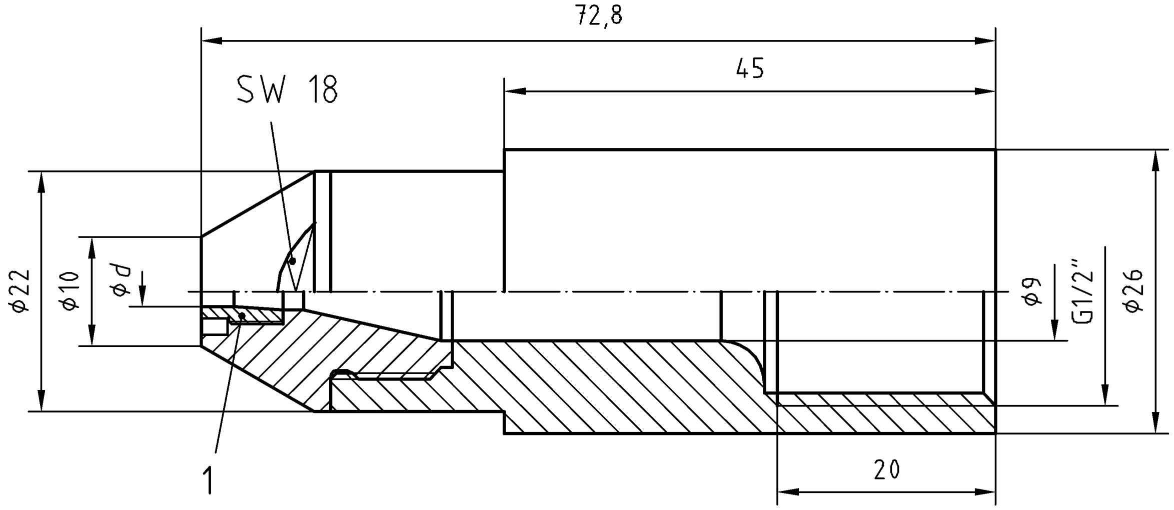


Figure 1a – Nozzle

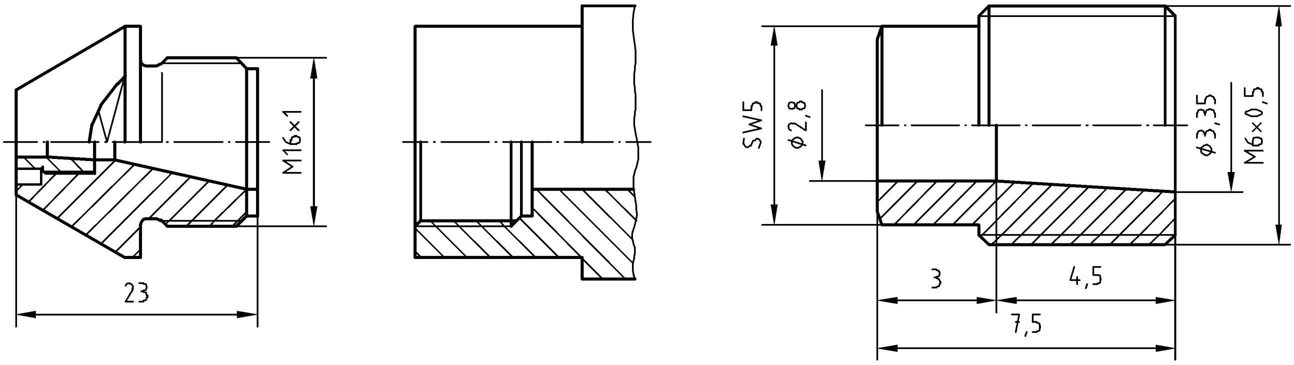


Figure 1 b — Nozzle details

Figure 1c — Nozzle insert

Figure 1 — Nozzle geometry

3.4 Test rig

The test rig is capable of supporting the test section and holding the nozzle at an angle α of $(30 \pm 1)°$ to the test surface, at a vertical distance h of (10^{0}_{-2}) mm measured to the centre of the orifice, from the internal test section surface. There is a means of moving the jet relative to the test section or vice versa. Ensure that this longitudinal traverse is parallel to the test section axis and the path of the jet is along the invert of the test section. The velocity of travel is (1 ± 0,1) metres per minute.

3.5 Test assembly

The test assembly shall consist of a half section pipe and a half section of a junction joined together, including the sealing element. A typical test assembly is shown in Figure 2. The overall length of the test assembly is at least 1,8 m to allow at least 150 mm beyond either end of the 1,5 m test length for change of direction of travel and acceleration to the test velocity.

In cases when it is impractical to include the sealing element into the test assembly, a separate test is carried out on a small test assembly comprising two short lengths of full section jointed pipes.

In cases were it is possible to do the tests on full sections, this is permitted if full evaluation can be guaranteed.

3.6 Procedure

3.6.1 Pre-test procedure

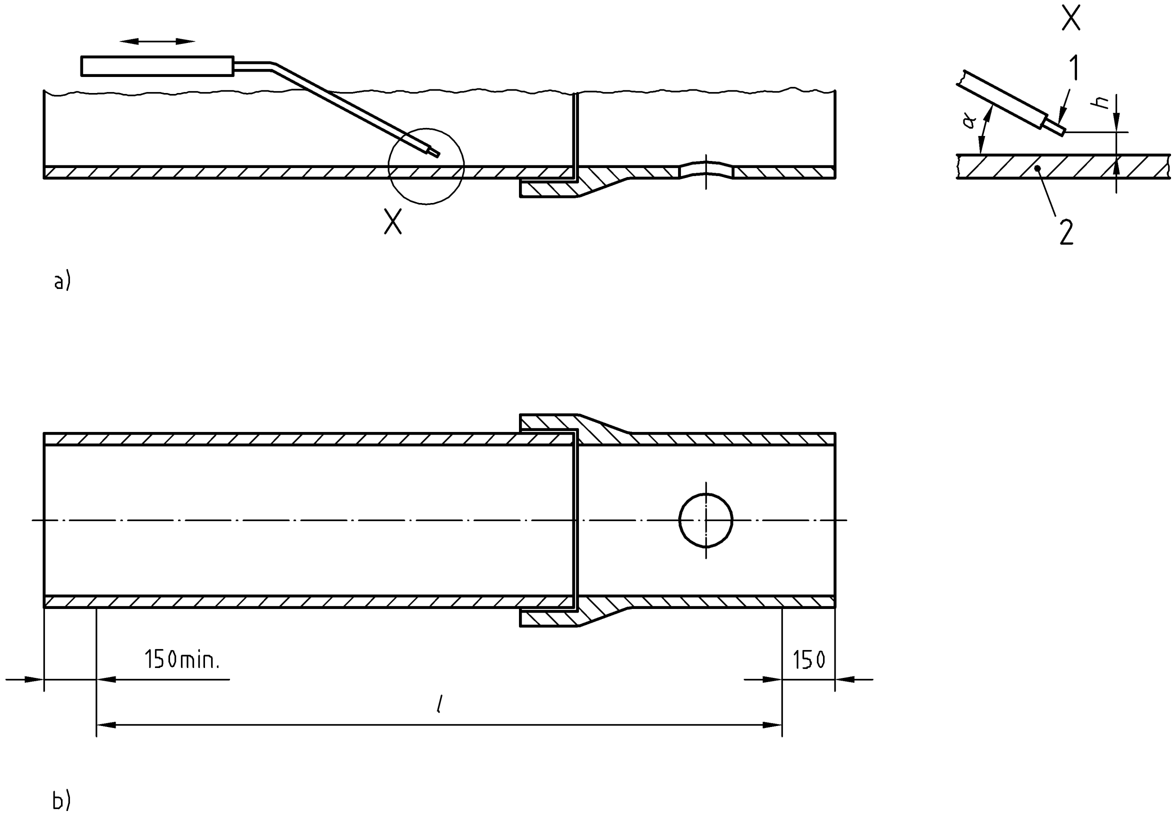
Start the pump unit with the flow running to dump, then divert to the nozzle, adjust the pressure p at (12 ± 0,2) MPa and measure the flow rate. Confirm that at this pressure the flow rate Q is (46 ± 1) l/min. If the flow is not in this range, then check the nozzle orifice diameter/conditions and all connections or replace the nozzle insert. Repeat the pre-test procedure until the unit is running at a steady rate at the specified conditions. Take a photograph and determine ω in accordance with Annex B.

The interior surface of the test length is inspected prior to testing and any imperfection is recorded.

Place the test assembly into the rig and adjust to level. The nozzle is fixed at α of (30 ± 1)° to the surface of the test assembly prior to the start of the test length, as given in Figure 2. Adjust the centre of the nozzle orifice to (10 +0/-1) mm vertically above the lowest point of the pipe invert along the test length.

3.6.2 Test procedure

Start the pump and ensure that the settings according to 3.6.1 are maintained. Move the test assembly relative to the jet or vice versa so that the jet travels along the line of the invert over the test length until it reaches at least 50 mm beyond the end of the test length. Reverse the direction of travel and repeat the process. The rate of travel is 1 m/min with the tolerance according to 3.4. Repeat this cycle 50 times. The interior surface of the test length is inspected after testing.



a)

b)

Key

1	Nozzle	l	test length
2	Pipe surface	h	vertical distance between the test surface and the centre of the nozzle orifice (see 2.2)
a	side view		
b	plan view	α	angle of the jet axis to the test surface (see 2.2)

Figure 2 — Typical test assembly

3.7 Recording of test results

The following parameters are recorded

a) Any imperfection noticed before testing

b) clear identification of test pipes;

c) ambient temperature and water inlet temperature in °C;

d) test pressure p in MPa;

e) nozzle orifice diameter d in mm;

f) flow rate Q in l/min;

g) jet spread angle ω

h) a description of the appearance of the test surface after completion of 50 cycles

NOTE Guidance concerning the evaluation of surface damage is given in informative Annex A.

Annex A
(informative)

Guidance on the evaluation of surface damage

For the evaluation of surface damage reference should be made to the appropriate clauses specifying acceptable surface appearance in the relevant product standards.

EN 295-1:1991, *Vitrified clay pipes and fittings and pipe joints for drains and sewers — Part 1: Requirements.*

EN 588-1:1996, *Fibre-cement pipes for sewers and drains —art 1: Pipes, joints and fittings for gravity systems*.

EN 598:1994, *Ductile iron pipes, fittings, accessories and their joints for sewerage application — Requirements and test methods.*

EN 877:1999, *Cast iron pipes and fittings, their joints and accessories for the evacuation of water from buildings — Requirements, test methods and quality assurance.*

EN 1916:2002, *Concrete pipes and fittings, unreinforced, steel fibre and reinforced*.

EN 1401-1:1998, *Plastics piping systems for non-pressure underground drainage and sewerage - Unplasticized poly(vinyl chloride) (PVC-U) - Part 1: Specifications for pipes, fittings and the system.*

EN 1852-1:1998, *Plastics piping systems for non-pressure underground drainage and sewerage - Polypropylene (PP) - Part 1: Specifications for pipes, fittings and the system*.

prEN 12666-1, *Plastics piping systems for non-pressure underground drainage and sewerage - Polyethylene (PE) - Part 1: Specifications for pipes, fittings and the system.*

prEN 13476-1, *Plastics piping systems for non-pressure underground drainage and sewerage - Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) - Part 1: Specifications for pipes, fittings and the system.*

EN 13566-1, *Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks - Part 1: General*.

EN 13566-2, *Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks - Part 2: Lining with continuous pipes*.

EN 13566-3, *Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks - Part 3: Lining with close-fit pipes*.

EN 13566-4, *Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks - Part 4: Lining with cured-in-place pipes.*

prEN 14758-1, *Plastics piping systems for non-pressure underground drainage and sewerage - Polypropylene with mineral modifiers (PP-M) - Part 1: Specifications for pipes, fittings and the system*

Annex B
(normative)

Determination of jet spread angle

Dimensions in mm

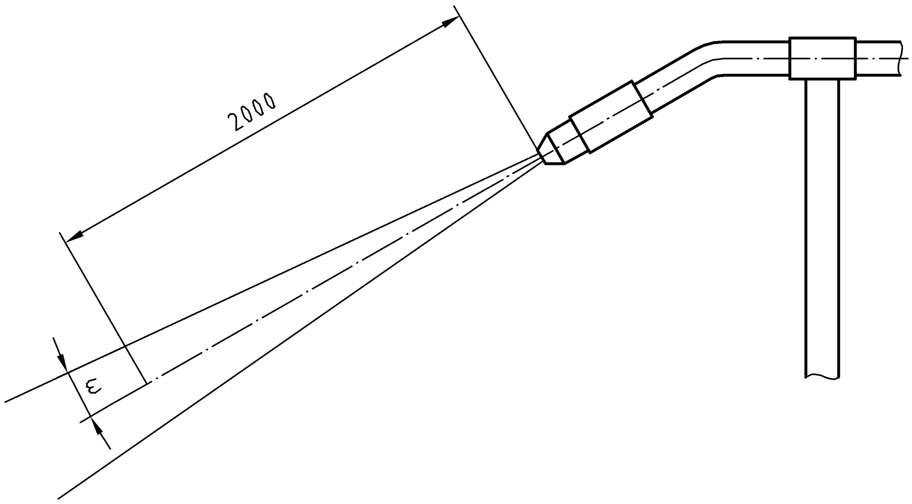


Figure B.1 — Flow picture

The jet spread angle ω is determined by taking the photograph as specified in 3.6.1 and drawing a figure similar to Figure B.1 on the jet seen on the photograph.

Annex C
(informative)

Basic Principles for calculation of C_d, P_j and D_j

C.1 Calculation of C_d

Considering that

$$Q = A \cdot v$$

where

Q is the flow rate expressed in $\mathrm{m^3/s}$

A is the cross sectional area of the orifice of the nozzle expressed in $\mathrm{m^2}$

v is the velocity expressed in m/s

considering that

$$A = \frac{\pi \cdot d^2}{4}$$

where

d is the diameter of the Nozzle, expressed in mm

$$\mathrm{v} = C_\mathrm{d} \cdot \sqrt{2g \cdot H}$$

$$Q = C_\mathrm{d}\left(\frac{\pi}{4}\sqrt{2g}\right) \cdot d^2 \cdot \sqrt{H}$$

$$C_\mathrm{d} = \frac{4}{\pi\sqrt{2g}} \cdot \frac{Q}{d^2 \cdot \sqrt{H}}$$

$$C_\mathrm{d} = 0{,}2875 \times \frac{Q}{d^2 \cdot \sqrt{H}}$$

where

Q is expressed in $\mathrm{m^3/s}$ which is equal to 6×10^4 l/min

d^2 is expressed in $\mathrm{m^2}$ which is equal to $1 \times 10^6\ \mathrm{mm^2}$

C_d is the coefficient of discharge

H is the height of water column expressed in m

Considering that

$$p = \rho_\mathrm{W} \cdot g \cdot H$$

where

p is the pressure measured not more than one metre upstream of the nozzle expressed in Pa or N/m^2

ρ_W is the density of water expressed in 10^3 kg/m^3

g is the gravity factor expressed in 9,80629 m/s^2

and considering that

$$p = 10^{-6} \times 9{,}806 \times 10^3 \times H \quad \text{is expressed in} \quad \frac{\mathrm{kg}}{\mathrm{m}^3}\cdot\frac{\mathrm{m}}{\mathrm{s}^2}\cdot\frac{\mathrm{m}}{1} = \frac{\mathrm{kg}\cdot\mathrm{m}}{\mathrm{s}^2}\cdot\frac{1}{\mathrm{m}^2} = \frac{\mathrm{N}}{\mathrm{m}^2}$$

$$p = 0{,}9806 \times 10^{-2} \times H \quad \text{is expressed in} \quad \mathrm{MPa}$$

$$H = 1{,}0197 \times 10^2 \times p \quad \text{is expressed in} \quad \mathrm{m}$$

then

$$C_\mathrm{d} = 0{,}2875 \times \frac{Q}{6 \times 10^4} \times \frac{10^6}{d^2} \cdot \frac{1}{\sqrt{p \times 1{,}0197 \times 10^2}}$$

The coefficient of discharge of the nozzle (C_d) is calculated as follows:

$$C_\mathrm{d} = 0{,}474 \times \frac{Q}{d^2 p^{1/2}}$$

where

Q is expressed in l/min

d is expressed in mm

p is expressed in MPa

The arithmetic mean of three determinations is taken as the value of C_d for the nozzle.

C.2 Jet Power P_j

$$P_\mathrm{j} = \rho_w \cdot g \cdot Q \cdot \frac{v^2}{2 \times g} \quad \text{is expressed in} \quad \frac{\mathrm{kg}}{\mathrm{m}^3}\cdot\frac{\mathrm{m}}{\mathrm{s}^2}\cdot\frac{\mathrm{m}^3}{\mathrm{s}}\cdot\frac{\mathrm{m}^2}{\mathrm{s}^2}\cdot\frac{\mathrm{s}^2}{\mathrm{m}} \mathrel{\hat{=}} \frac{\mathrm{kg}\cdot\mathrm{m}}{\mathrm{s}^2}\cdot\frac{\mathrm{m}}{\mathrm{s}} \mathrel{\hat{=}} \frac{\mathrm{N}\cdot\mathrm{m}}{\mathrm{s}} = \mathrm{W}$$

where

$$\rho_\mathrm{w} = 1 \times 10^3 \quad \text{is expressed in} \quad \frac{\mathrm{kg}}{\mathrm{m}^3};$$

$$g = 9{,}80629 \quad \text{is expressed in} \cdot \frac{\mathrm{m}}{\mathrm{s}^2};$$

considering that:

$v = C_\mathrm{d} \cdot v_2$ and $v_2{}^2 = 2 \times g \cdot H$

where

v_2 is the theoretical velocity at the exit of the nozzle (orifice of the nozzle)

then

$$P_\mathrm{j} = \rho_\mathrm{w} \cdot g \cdot Q \cdot \frac{C_\mathrm{d}{}^2 \cdot 2 \times g \cdot H}{2 \times g}$$

$$P_\mathrm{j} = \frac{\rho_\mathrm{w} \cdot Q}{2} \cdot C_\mathrm{d}{}^2 \times 2 \times g \cdot H$$

$$P_\mathrm{j} = \frac{\rho_\mathrm{w} \cdot Q}{2} C_\mathrm{d}{}^2 \times 2 \times 9{,}80629 \times 1{,}0197 \times 10^2 \times p$$

$$P_\mathrm{j} = \frac{\rho_\mathrm{w} \cdot Q}{2} C_\mathrm{d}{}^2 \times 2000 \times p$$

if Q is expressed in $\frac{\mathrm{l}}{\mathrm{min}}$

p is expressed in MPa

then

$$P_\mathrm{j} = 10^3 \times \frac{Q \times 2000}{2 \times 6 \times 10^4} \cdot C_\mathrm{d}{}^2 \cdot p$$

then

$$P_\mathrm{j} = 16{,}67 \times C_\mathrm{d}{}^2 \cdot Q \cdot p$$

C.3 Jet Power Density D_j

D_j is expressed in $\frac{\mathrm{W}}{\mathrm{mm^2}} = \frac{P_\mathrm{j}}{a}$

considering that:

$$a = \frac{A}{\sin\alpha}$$

NOTE The calculation of a, where d is the nozzle orifice diameter, is valid for values of h (distance) up to 25 mm; in other cases the spread of the jet should be taken into consideration;

$$A = \frac{\pi \cdot d^2}{4}$$

$$D_\mathrm{j} = \frac{P_\mathrm{j}}{a} = P_\mathrm{j} \cdot \frac{4}{\pi \cdot d^2} \cdot \frac{\sin\alpha}{1}$$

$$D_\mathrm{j} = 16{,}666 \times C_\mathrm{d}{}^2 \cdot p \cdot Q \cdot \frac{4}{\pi \cdot d^2} \cdot \frac{\sin\alpha}{1}$$

considering that:

$$Q = \frac{1}{0{,}4745} \times C_{\mathrm{d}} \cdot d^2 \cdot p^{1/2}$$

$$Q = 2{,}1075 \times C_{\mathrm{d}} \cdot d^2 \cdot p^{1/2}$$

$$D_{\mathrm{j}} = 16{,}666 \times {C_{\mathrm{d}}}^2 \cdot p \times 2{,}1075 \times C_{\mathrm{d}} \cdot d^2 \cdot p^{1/2} \cdot \frac{4 \cdot \sin\alpha}{\pi \cdot d^2}$$

$$D_{\mathrm{j}} = 44{,}72 \times {C_{\mathrm{d}}}^2 \cdot p \cdot C_{\mathrm{d}} \cdot p^{1/2} \cdot \sin\alpha$$

then

$$D_{\mathrm{j}} = 44{,}72 \times {C_{\mathrm{d}}}^3 \cdot p^{3/2} \cdot \sin\alpha$$

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